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Effect of irrigation on cotton production on the Loessial soils of the Macon Ridge in northeast Louisiana

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The climate in northeast Louisiana is classified as humid and subtropical and is characterized by moderate temperatures and annual rainfall that exceeds evaporation. Average annual rainfall is 54 inches, while potential evapotranspiration (PE) losses average 41 inches (*16*)[2]. The PE is an estimate of evaporative demand, the maximum amount of water that can be removed from the soil through evaporation and plant transpiration in a well-watered soil-plant system. Actual evapotranspiration losses from the soil are very similar to PE under optimum moisture conditions. However, as each increment of available moisture is removed from the soil, the energy required by the plant to extract the next increment increases. Thus, as the amount of moisture in the soil decreases, actual evapotranspiration losses are reduced accordingly. This is an important concept since evapotranspiration is highly correlated with agronomic productivity.

Since annual rainfall exceeds the PE by about 13 inches, it might first appear that insufficient water should not be a limiting factor for plant growth in this area. However, rainfall is not uniformly distributed through the year and PE rates also vary greatly during the year. Rainfall averages about 5 inches per month from October through May. During this period, PE rates average about 2 inches per month. Thus, during the fall, winter, and early spring months, there is an actual surplus of about 3 inches per month. Most of the surplus water is lost from fields as surface runoff and, to a lesser extent, as deep percolation below the root zone. During the June through September growing season for cotton, rainfall averages only 3.5 inches per month. These low rainfall amounts combine with PE rates of 6 to 7 inches per month to cause an actual moisture deficit of approximately 2.5 to 3.5 inches per month.

During periods of excess rainfall, the soil serves as a reservoir for the storage of moisture that can be utilized by plants during periods when crop water requirements exceed rainfall. Soils vary greatly in their capacities to serve as reservoirs of soil moisture. The loessial silt loam soils of the Macon Ridge are not very effective in this respect. These medium-textured soils are

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[2]Italic numbers in parentheses refer to Literature Cited, page 19.

typically low in organic matter and have poor physical structure, which results in low water storage capacities per unit volume of soil and low water infiltration rates (*7*). The topography in many areas is undulating, so runoff losses of water can be very high during the intense thunderstorms which provide much of the rainfall during the summer.

Finally, the subsoil is very acidic and fragipans are quite common, so plant root systems are concentrated near the soil surface which severely limits the effective size of the soil water reservoir (*7*). Preliminary results of a study at the Macon Ridge branch of Northeast Research Station indicate that approximately 18 inches is the maximum rooting depth for cotton and soybeans on these soils (*8*). Other studies have shown that these soils will hold approximately 4 inches of plant-available water to a depth of 18 inches (*7,20*).

It has long been recognized that lack of soil moisture is frequently a factor that limits cotton yields on the Macon Ridge. Irrigation research has been conducted at the Macon Ridge branch station for over 20 years to study the effect of supplemental water on the performance of cotton and to determine optimum production practices for this crop under irrigated conditions (*5,8,9,10,11*).

Recently, marked increases in cotton production costs have made it economically essential to consistently produce high yields, causing a renewed interest in irrigation. The purpose of this bulletin is to summarize recent cotton irrigation research on the loessial terrace soils of northeast Louisiana, thus providing current information on the expected effects of irrigation on cotton lint yields, fiber quality, and earliness of maturity.

Materials and Methods

Each year from 1971-83, two cotton variety tests were conducted on Gigger silt loam soil (fine-silty, mixed, thermic Typic Fragiudalfs) at the Macon Ridge branch station. These two tests were conducted in adjacent blocks and all aspects of production were basically identical except that one test was furrow irrigated and the other test received no irrigation. However, late season insect control, defoliation requirements, and harvest dates for the irrigated and non-irrigated tests were often quite different because irrigation in dry years delayed crop maturity by 2 weeks or more. Information concerning planting dates, fertilization, and harvest dates for the irrigated and non-irrigated cotton variety tests are presented in Table 1.

Each test consisted of approximately 20 cotton varieties planted in a randomized complete block design with four replications. The varieties included in these tests differed each year due to the continuous development of new varieties and obsolescence of older varieties. From 1971-81, plots were two 40-inch rows wide and 50 feet long. From 1981-83, plots were four 40-inch rows 50 feet long. The tests were usually planted the first or

Table 1. – Planting dates, harvesting dates and fertilization of irrigated and non-irrigated cotton variety tests, Macon Ridge Research Station, 1971-83

Year	Planting[1] date	Fertilization[1] (N-P_2O_5-K_2O)	Date of first harvest Irrigated	Date of first harvest Non-irrigated	Date of second harvest Irrigated	Date of second harvest Non-irrigated
1971	5/17/71	125-60-60	11/04/71	11/04/71	—	—
1972	5/16/72	89-72-72	10/17/72	10/17/72	12/07/72	12/07/72
1973	5/21/73	84-72-72	11/19/73	11/19/73	—	—
1974	5/05/74	89-72-72	11/07/74	11/07/74	—	—
1975	5/19/75	56-48-48	11/12/75	11/12/75	12/10/75	12/10/75
1976	5/20/76	65-0-0	10/14/76	10/14/76	11/04/76	11/04/76
1977	5/09/77	65-0-0	09/30/77	09/30/77	10/31/77	10/31/77
1978	5/16/78	70-0-0	09/27/78	09/27/78	10/11/78	10/11/78
1979	5/09/79	65-0-0	—	10/11/79	—	11/08/79
1980	5/02/80	80-0-0	10/10/80	09/19/80	11/13/80	10/10/80
1981	5/13/81	80-0-0	10/28/81	09/25/81	11/16/81	11/13/81
1982	5/05/82	90-60-60	10/22/82	10/04/82	11/15/82	10/22/82
1983	5/26/83	80-0-0	11/01/83	10/11/83	11/16/83	10/25/83

[1]Irrigated and non-irrigated tests.

second week in May. Planting and cultivation were performed with four-row farm equipment, and recommended herbicides, insecticides, and defoliants were used on the test plots. The irrigated plots were furrow irrigated with gated pipe.

Examination of soil cores and vegetative plant growth was used to schedule water applications. In general, water was applied when the red coloration of the main stem approached to within 3 inches of the terminal bud from early bloom until late August. Monthly and yearly rainfall from 1963-83, and dates of irrigation and amounts of water applied to the irrigated test from 1971-83 are presented in Tables 2 and 3, respectively.

Prior to the first machine harvest, 50 open bolls were hand harvested from each plot. This hand harvested cotton was ginned on a 20-saw laboratory gin to determine lint percentage and to provide lint samples for fiber quality analyses. Lint samples were analyzed for important fiber characteristics by the Louisiana Agricultural Experiment Station (LAES) Cotton Fiber Testing Laboratory. Yields were determined by harvesting the two center rows of the four-row plots or both rows of the two-row plots with a mechanical spindle picker. Yield and fiber property data from the irrigated and non-irrigated tests were statistically analyzed to determine the effects of irrigation on yield and fiber quality of six cotton varieties (Stoneville 213, Stoneville 825, Deltapine 61, Deltapine 41, Deltapine 26 and DES 56) that were evaluated for 6 or more years.

Table 2. – Monthly rainfall, Macon Ridge Research Station, 1963-83

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1963	4.30	3.79	1.65	4.46	1.45	3.73	2.97	3.87	2.20	2.23	4.64	2.81
1964	4.23	2.68	7.91	9.74	2.00	1.92	4.77	3.29	3.59	0.80	4.62	6.38
1965	3.26	9.33	7.18	0.66	2.22	0.90	2.32	1.72	6.32	—	3.33	5.07
1966	6.03	11.76	2.66	10.57	2.36	1.17	4.44	4.70	8.32	2.47	3.43	5.57
1967	1.75	3.85	1.09	2.35	10.27	1.35	5.55	3.10	1.36	1.94	0.47	13.27
1968	8.26	2.70	4.96	9.39	5.53	3.10	4.99	5.59	1.33	1.38	10.20	5.10
1969	0.75	3.90	4.66	5.13	5.01	0.50	5.87	0.55	1.33	4.04	2.35	3.60
1970	2.08	2.97	4.05	1.71	4.43	2.79	4.63	6.56	6.95	6.53	2.46	3.28
1971	1.90	4.40	4.20	2.62	8.61	0.89	1.80	3.18	3.47	0.24	0.66	9.17
1972	7.94	3.29	3.61	2.39	4.31	1.46	4.79	2.54	1.27	4.22	5.89	7.10
1973	8.92	1.16	10.08	7.49	5.80	1.02	0.76	2.47	4.64	3.52	7.90	6.48
1974	15.34	4.58	3.55	5.88	3.21	5.23	2.50	5.89	5.44	5.83	5.50	7.21
1975	1.40	7.47	6.34	6.61	10.92	13.20	5.58	4.01	1.99	7.46	3.15	1.73
1976	3.72	2.89	10.17	0.96	7.70	5.81	2.48	0.86	0.97	1.67	3.59	4.12
1977	3.27	1.59	10.21	6.68	1.43	1.30	3.72	1.84	0.70	2.36	6.78	3.98
1978	5.02	2.83	1.91	2.11	8.37	2.30	1.59	3.63	1.25	0.51	3.13	7.99
1979	15.44	7.68	3.75	10.35	5.45	1.37	5.32	2.86	7.48	3.43	6.66	4.09
1980	3.91	2.66	11.86	7.72	6.96	3.64	2.76	0.56	3.33	4.48	4.24	0.78
1981	2.10	3.84	5.68	0.27	4.53	5.85	2.61	2.48	1.21	2.72	1.57	2.94
1982	3.02	5.71	4.49	7.52	2.51	10.29	4.31	3.19	4.36	5.35	7.13	17.60
1983	3.97	11.84	6.55	9.15	17.56	7.41	0.44	1.54	1.63	0.10	8.82	7.46
Average	5.08	4.81	5.55	5.42	5.74	3.58	3.53	3.07	3.29	3.06	4.58	5.99

Table 3. – Dates of irrigation and quantity of water applied to irrigated cotton variety tests, Macon Ridge Research Station, 1971-83

Year	Irrigation Dates							Irrigation No.	Irrigation Inches
1971	6/22	7/12	8/23					3	6
1972	7/28	8/07						2	4
1973	7/16	7/25	8/08					3	6
1974	7/01	7/17						2	4
1975[1]								0	0
1976	7/28	8/10	8/30					3	6
1977	6/13	7/17	8/05	8/26				4	8
1978	7/10	7/17	7/24	7/31	8/07	8/14	8/21	7	14
1979[2]								0	0
1980	7/16	7/30	8/08	8/13	8/19	8/28		6	12
1981	7/17	7/24	7/30	8/07	8/24	8/31		6	12
1982	7/19	7/27	8/13					3	6
1983	7/03	7/25	8/23					3	6
Average								3.2	6.4

[1]Irrigation was not necessary in 1975 due to adequate rainfall during the growing season.
[2]Irrigation was not necessary in 1979 due to mechanical problems with irrigation well.

Results and Discussion

Rainfall and Irrigation

Information concerning rainfall, dates of irrigation, and amounts of water applied is presented in Tables 2 and 3. Usually, irrigation was not necessary until July; however in 1971 and 1977 water applications were required in June. It was necessary to irrigate until mid- to late August in most years. No irrigation was needed in 1975 due to adequate rainfall during June, July and August. Irrigation was not possible in 1979 due to mechanical problems with the irrigation system. Average annual water application was 6.4 inches applied in 2-inch increments over a period of about 2 months. This coincided with the time of flowering, and boll setting and boll development. The cutoff date for irrigation, always a very judgmental decision, requires some deliberation over maximizing yields without delaying harvest too long. Irrigation was usually terminated when a few bolls were open near the base of the plants and the majority of the unopened bolls were mature.

As previously mentioned, significant periods of soil water surplus and deficit occur during the year. Average rainfall exceeds potential evapotranspiration (PE) from November through May, resulting in a net water surplus until early June (*16*). At that time, the available stored moisture in the 18-inch soil profile will be near full capacity in an average year. It has been estimated that the 18-inch soil profile, from which plants extract most of their water, holds approximately 4 inches of plant-available water at full capacity (*7,20*). The average rainfall for June is 3.5 inches while PE losses are about 6 inches. This represents a moisture deficit of 2.5 inches. Thus, during June, plants may be expected to utilize most of the available moisture stored in the soil to a depth of 18 inches. The months of July and August are critical months for cotton production since this period coincides with the time of flowering, boll setting and boll development. This is also usually a period of serious soil moisture deficits since PE rates approach 7 inches per month and rainfall averages 3 to 3.5 inches per month. Therefore, during this 2-month period, water deficits of 3.5 to 4 inches per month, or a total of 7 to 8 inches, would be anticipated. This estimated deficit is consistent with the average amount of irrigation water (6.4 inches) applied in these experiments.

Yield Response

Stoneville 213 was evaluated under irrigated and non-irrigated conditions at Macon Ridge from 1971-83. The average yield for this variety during this 13-year period under non-irrigated conditions was 585 pounds of lint per acre (Table 4). With irrigation, the average yield was 934 pounds per acre. This represents an average lint yield increase of 60 percent, due to irrigation. During this period, the lint yield increases ranged from 3 pounds per acre in 1972 to 769 pounds in 1981. As one might expect, the largest yield increases occurred in years when rainfall during the critical months of July and August was lowest, such as in 1971, 1980, and 1981.

Stoneville 825 was evaluated from 1977-83. Average yield of this variety under dryland conditions was 653 pounds of lint per acre compared with 1,093 pounds with irrigation (Table 4). Thus, irrigation increased yields of this variety by an average of 440 pounds of lint per acre, or 67 percent. During this 7-year period, yield increases ranged from 119 pounds in 1982 to 860 pounds in 1981. Yield increases with Stoneville 825 from 1977-83 were similar to those obtained with Stoneville 213 during the same period.

Irrigated and non-irrigated lint yields for Deltapine 61 from 1975-83 are presented in Table 5. Without irrigation, the 9-year average lint yield of this variety was 575 pounds per acre compared with 1,017 pounds with irrigation. This represents an average yield increase of 442 pounds per acre, or about 77 percent. Responses to irrigation ranged from a 152-pound yield reduction in 1975 to a 902-pound increase in 1981.

Deltapine 41 was first evaluated at Winnsboro in 1977. During 1977-83, this variety produced average yields of 567 and 1,107 pounds of lint per acre under non-irrigated and irrigated conditions, respectively (Table 5). Thus, the average yield of this variety was increased by 540 pounds of lint per

Table 4. – Irrigated and non-irrigated yields for Stoneville 213 and Stoneville 825 cotton varieties, Macon Ridge Research Station, 1971-83

Year	Stoneville 213			Stoneville 825		
	Non-irrigated	Irrigated	Increase	Non-irrigated	Irrigated	Increase
	Pounds Lint/Acre			Pounds Lint/Acre		
1971	523	1126	603	—	—	—
1972	736	739	3	—	—	—
1973	424	792	368	—	—	—
1974	366	425	59	—	—	—
1975[1]	835	951	116	—	—	—
1976	339	784	445	—	—	—
1977	713	920	207	701	870	169
1978	477	1007	530	591	1056	465
1979[2]	820	—	—	897	—	—
1980	385	1002	617	485	1128	643
1981	380	1149	769	371	1231	860
1982	792	906	114	737	856	119
1983	818	1411	593	788	1418	630
Average	585	934	349*[3]	653	1093	440*

[1]Irrigation was not needed in 1975 due to adequate rainfall.
[2]Irrigated yields for 1979 were not available since only a non-irrigated test was conducted that year due to mechanical problems with the irrigation well.
[3]Significant at the .05 level of probability.

Table 5. – Irrigated and non-irrigated yields for Deltapine 61 and Deltapine 41 cotton varieties, Macon Ridge Research Station, 1975-83

Year	Deltapine 61			Deltapine 41		
	Non-irrigated	Irrigated	Increase	Non-irrigated	Irrigated	Increase
	Pounds Lint/Acre			Pounds Lint/Acre		
1975[1]	818	666	−152	—	—	—
1976	324	748	424	—	—	—
1977	732	869	137	627	827	200
1978	454	1039	585	483	1190	707
1979[2]	844	—	—	790	—	—
1980	322	1109	787	281	994	713
1981	374	1276	902	306	1119	813
1982	667	972	305	768	937	169
1983	643	1457	814	713	1577	864
Average	575	1017	442*[3]	567	1107	540*

[1]Irrigation was not needed in 1975 due to adequate rainfall.
[2]Irrigated yields for 1979 were not available since only a non-irrigated test was conducted that year due to mechanical problems with the irrigation well.
[3]Significant at the .05 level of probability.

acre, or 95 percent. Yield increases ranged from 169 pounds in 1982 to 864 pounds in 1983.

The varieties Deltapine 26 and DES 56 were evaluated during a 6-year period from 1977-82 (Table 6). The average yield of Deltapine 26 was increased by 434 pounds per acre, or about 77 percent. Irrigation increased the yield of DES 56 by 412 pounds per acre, or 72 percent.

These data suggest that irrigation tended to result in larger yield increases with the Deltapine varieties than with the Stoneville varieties, particularly in dry years such as 1980 and 1981. This is likely due to a slightly greater degree of drought tolerance associated with the Stoneville varieties as compared with the Deltapine varieties. This has been observed in the non-irrigated variety tests and preliminary observations indicate the slightly greater drought tolerance may be due to more extensive and deeper root systems in the Stoneville varieties on this acidic soil (*3,4*). The Deltapine varieties have tended to produce slightly higher lint yields than the Stoneville varieties under irrigated conditions.

As an average of all varieties and years, non-irrigated cotton yielded 586 pounds vs. 1,023 pounds of lint per acre for irrigated cotton. This is an average yield increase of 437 pounds of lint per acre, or 75 percent. Even if one chose to be conservative and used the lowest yield increase of 349 pounds of lint per acre obtained with Stoneville 213 over a 13-year period, it is still apparent that irrigation can increase cotton yields dramatically on the loessial silt loam soils of the Macon Ridge.

Boll Weight

Irrigation increased boll weight each year from 1977-83 (Table 7). The largest increases in boll weight were obtained in 1978, 1980, and 1981 due to extremely droughty conditions that occurred during July and August of those years. Averaged across the six varieties and 6 years, irrigation significantly reduced the number of bolls per pound from 100 for non-irigated cotton to 84.4, a reduction of more than 15 percent. These data indicate that the yield increases obtained with irrigation could be partially attributed to increases in boll size.

Lint Percentage

As an average of varieties and years, irrigation had no significant effect on lint percentage (Table 7). The average lint percentages for irrigated and non-irrigated conditions were 40.7 and 40.9, respectively. Since lint percentage was not affected significantly, it may be concluded from these data that the yield increases obtained with irrigation were attributed to an increase in boll size and number of bolls harvested.

Table 6.—Performance of Deltapine 26 and DES 56 in the irrigated and non-irrigated cotton varieties tests, Macon Ridge Research Station, 1977-82

Year	Deltapine 26			DES 56		
	Non-irrigated	Irrigated	Increase	Non-irrigated	Irrigated	Increase
	Pounds Lint/Acre			Pounds Lint/Acre		
1977	667	895	228	682	916	234
1978	528	1077	549	457	1084	627
1979[1]	846	—	—	863	—	—
1980	280	998	718	285	1067	782
1981	346	1161	815	412	985	573
1982	736	876	140	745	877	132
Average	567	1001	434*[2]	574	986	412*

[1]Irrigated yields for 1979 were not available since only a non-irrigated test was conducted that year due to mechanical problems with the irrigation well.

[2]Significant at the .05 level of probability.

Table 7. – Effects of irrigation on boll weight and lint percentage of cotton, Macon Ridge Research Station, 1977-83[1]

	Bolls per pound of seedcotton			Lint percentage		
Year	Non-irrigated	Irrigated	Difference	Non-irrigated	Irrigated	Difference
1977	95.0	82.3	−12.7	42.7	41.1	−1.6
1978	98.3	77.5	−20.5	41.3	41.3	0.0
1980	107.1	86.7	−20.4	38.3	40.7	+2.4
1981	104.0	86.0	−18.0	38.6	40.0	+1.4
1982	98.2	91.3	−6.9	42.3	39.7	−2.6
1983	95.8	82.0	−13.8	43.0	41.8	−1.2
Average	100.0	84.4	−15.6	40.9	40.7	−0.2
LSD (.05)		5.8			NS	

[1]Values for 1977-82 are an average for six varieties (Stoneville 213, Stoneville 825, Deltapine 61, Deltapine 41, Deltapine 26, and DES 56). Values for 1983 are averaged across four varieties (Stoneville 213, Stoneville 825, Deltapine 61 and Deltapine 41). Data from 1979 are not available due to mechanical problems that prevented irrigation.

Fiber Properties

Micronaire readings were not significantly affected by irrigation when averaged across varieties and years (Table 8). The average micronaire reading of irrigated cotton was 5.1 compared with 4.9 under non-irrigated conditions. These data do suggest, however, that in very dry years, such as 1978, 1980, and 1981, irrigation tended to increase micronaire readings.

Averaged over years, irrigation significantly increased fiber 2.5 percent span length from 1.08 inches for non-irrigated cotton to 1.13 inches, an increase of .05 inch (Table 8). Irrigation increased fiber length every year from 1977-83 with the largest increases occurring in 1978 and 1981. Since fiber length is an important factor in determining the value of cotton, these data indicate that irrigation is a useful management practice for increasing cotton quality and subsequently the price received by farmers for their crop. Fiber strength was not affected significantly by irrigation (Table 8). Average fiber strength for the six varieties under irrigated and non-irrigated conditions was 23 and 23.4 grams/tex, respectively. Fiber strength of the non-irrigated cotton tended to be more variable from year to year than the irrigated cotton. These data are in close agreement with other studies conducted across the south which also indicate that irrigation tended to increase fiber length and generally stabilized and improved fiber quality (*1,2,6,12,13,14,15*).

Earliness of Maturity

During the period from 1971-79, both the irrigated and non-irrigated tests were simultaneously harvested when the cotton in the irrigated test was mature enough for efficient machine harvesting. In some years, such as

Table 8. – Effects of irrigation on selected fiber characteristics of cotton, Macon Ridge Research Station, 1977-83[1]

Year	Micronaire			Fiber 2.5% Span length (inches)			1/8" Gauge Strength index gram/tex		
	Non-irrigated	Irrigated	Difference	Non-irrigated	Irrigated	Difference	Non-irrigated	Irrigated	Difference
1977	5.2	5.2	0.2	1.10	1.14	0.04	22.2	22.5	+0.3
1978	4.9	5.3	0.4	1.06	1.15	0.09	22.0	22.9	+0.9
1980	4.7	5.2	0.5	1.09	1.11	0.02	24.8	24.4	−0.4
1981	4.7	5.0	0.3	1.09	1.14	0.05	25.3	22.6	−2.7
1982	5.0	4.9	0.1	1.05	1.09	0.04	22.9	22.8	−0.1
1983	5.0	5.0	0.0	1.10	1.14	0.04	22.9	22.5	−0.4
Average	4.9	5.1	0.2	1.08	1.13	0.05	23.38	23.0	
LSD (.05)	NS			0.02			NS		

[1]Values for 1977-82 are an average for six varieties (Stoneville 213, Stoneville 825, Deltapine 61, Deltapine 41, Deltapine 26, and DES 56). Values for 1983 are averaged across four varieties (Stoneville 213, Stoneville 825, Deltapine 61, and Deltapine 41). Data from 1979 are not available due to mechanical problems that prevented irrigation.

1971, 1974, and 1975, a once-over harvest of both tests was possible by allowing all the cotton to open prior to harvesting. Data from this period do not allow a comparison of earliness between the irrigated and non-irrigated varieties. However, from 1980-83, the non-irrigated and irrigated tests were separately harvested when most of the varieties in each test reached approximately 80-90 percent open. This approach to harvesting allowed a comparison of earliness between the irrigated and non-irrigated cotton in terms of days required from planting to first harvest. As shown in Table 9, irrigation delayed first harvest of Stoneville 213, Stoneville 825, Deltapine 61, and Deltapine 41 by approximately 3 weeks. In 1980, 1982, and 1983, the final harvest of the non-irrigated test was possible at about the same time or slightly earlier than the first harvest of the irrigated test (Table 1). Irrigation generally delayed maturity of the cotton by extending the fruiting period and preventing early cut-out of the plants. Although a delay in maturity is an undesirable aspect of irrigation from the standpoint of insect control and timely harvest, it appears that, with the varieties currently

Table 9. – Effect of irrigation on date of maturity for selected cotton varieties, Macon Ridge Research Station, 1980-83

	Days from planting to first harvest			Percent first harvest		
Year	Non-irrigated	Irrigated	Difference	Non-irrigated	Irrigated	Difference
			Stoneville 213			
1980	140	161	+21	72.2	81.5	+9.3
1981	135	168	+33	77.1	80.6	+3.5
1982	152	170	+18	90.7	89.6	−1.1
1983	138	159	+21	87.7	88.6	+0.9
Avg.	141	165	+24	81.9	85.1	+3.2
			Stoneville 825			
1980	140	161	+21	87.6	88.4	+0.8
1981	135	168	+33	79.9	86.7	+6.8
1982	152	170	+18	92.0	85.4	−6.6
1983	138	159	+21	87.1	88.8	+1.7
Avg.	141	165	+24	86.7	87.3	+0.6
			Deltapine 61			
1980	140	161	+21	60.6	85.3	+24.7
1981	135	168	+33	79.8	84.6	+4.8
1982	152	170	+18	84.8	88.7	+3.9
1983	138	159	+21	82.4	84.4	+2.0
Avg.	141	165	+24	76.9	85.8	+9.9
			Deltapine 41			
1980	140	161	+21	70.4	82.8	+11.8
1981	135	168	+33	72.2	82.2	+10.0
1982	152	170	+18	88.3	88.6	+0.3
1983	138	159	+21	85.8	85.9	+0.1
Avg.	141	165	+24	79.2	84.9	+5.7

Table 10. – Estimated costs and returns for three types of irrigation systems used for cotton production

Type system	Projected minimum yield increase	Estimated value of yield increase at 70¢/lb.	Estimated irrigation cost[2]	Additional production costs[3]	Estimated net return
	lb. lint/acre	dollars/acre			
130-acre Center Pivot System	349	244	93	27	124
100-acre Traveling Gun	349	244	106	27	111
100-acre Furrow System[1]	349	244	62	27	155

[1]Land leveling costs not included.

[2]Includes ownership and operation costs for application of 6 inches of water per year (*17,18*).

[3]Includes costs of two insecticide applications at $6/application; defoliation at $7/acre and 30 lbs. of nitrogen per acre at 25¢/lb. Additional hauling costs are not included.

recommended for the Macon Ridge, this delay in maturity is unavoidable if optimum yields are to be obtained.

Economic Considerations

In order to be economically feasible, irrigation must increase yields enough to cover the associated added costs of production. An elementary economic analysis of the observed yield increases obtained with irrigation is presented in Table 10. Irrigation costs are quite variable and are dependent upon many factors, especially the type of irrigation system and the amount of water applied. The annual ownership and operating costs for a 130-acre center pivot sprinkler system used to apply 6 inches of water has been estimated to be about $93 per acre (*17,18*). This can be compared with $106 per acre for a 100-acre traveling gun system and $62 per acre for a 100-acre furrow irrigation system. (*17,18*). It should be noted here that these cost estimates for furrow irrigation do not include land leveling costs, which are also quite variable. Research has shown that irrigation tends to prolong the fruiting period and delay the maturity of cotton. As a result, irrigated cotton may require two additional insecticide applications at an approximate cost of $6 per acre per application. Irrigated cotton often requires chemical defoliation, which usually costs about $7 per acre, while dryland cotton on the Macon Ridge can usually be harvested efficiently without defoliation. Also, studies by Phillips (*9*) have demonstrated that irrigated cotton responds to higher rates of nitrogen fertilization than non-irrigated cotton. In these studies, 60 pounds of nitrogen per acre was generally sufficient for optimum yields of non-irrigated cotton while approximately 90 pounds was necessary to provide optimum yields with irrigation. At current prices, the additional fertilizer cost would be about $8 per acre. Thus, it costs about $90-130 more per acre to produce irrigated cotton than non-irrigated. However, as shown in Table 10, the yield increases obtained in these studies have been more than adequate to justify the added expenses associated with irrigation. The estimated net returns from irrigation ranged from $111 per acre with the traveling gun to $155 per acre with furrow irrigation when cotton lint was valued at 70¢ per pound.

Summary

Irrigation studies at the Macon Ridge branch station have demonstrated that cotton yields on the Macon Ridge can be substantially increased with irrigation. With an average of 6.4 inches per year of irrigation water applied to the irrigated tests during the period from 1971-83, lint yields of Stoneville 213 were increased by an average of 349 pounds per acre. Average yield increases of newer varieties tested from 1976-83 ranged from 412-540 pounds of lint per acre. Therefore irrigation appears to be a tool that can significantly increase the profitability of cotton production on the droughty soils of the Macon Ridge. An economic analysis indicated net returns could be increased a minimum of $100 per acre.

Irrigation resulted in a significant increase in boll weight. During the period from 1977-83, the average boll weight of six cotton varieties was increased by approximately 15 percent. Lint percentage was not affected significantly by irrigation. Thus, the yield increase associated with irrigation was due to an increase in the number and weight of bolls harvested.

Fiber length of six cotton varieties was significantly increased from 1.08 inches to 1.13 inches with irrigation. This represents an increase in length of .05 inch or approximately 5 percent. Fiber strength and micronaire were not significantly affected by irrigation.

Irrigation delayed maturity of six cotton varieties each year from 1980-83 with an average delay of approximately 3 weeks. This delay in maturity is an undesirable aspect of irrigation from a crop management standpoint. However, this delay appears to be unavoidable if yields of cotton are to be optimized with irrigation.

There is little question that irrigation of cotton can be a profitable production practice on the droughty soils of the Macon Ridge. But, in order to obtain the best possible returns from irrigation, growers must realize that irrigated cotton generally demands more skillful management than dryland cotton. Research has demonstrated that fertilization, insect control, and defoliation requirements of irrigated cotton are often quite different from non-irrigated cotton in the same field. This is due primarily to the higher yield potential and later maturity of the irrigated cotton. Also, variety selection is very important since some varieties appear to perform better under irrigated conditions than others.

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